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A SYNOPSIS OF BIOLOGICAL DATA ON TENCH

TINCA TINCA (Linnaeus 1758)

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H. Rosa, Jr.

FAO Fisheries Biology Branch

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F O R E W O R D

The information in this synopsis is based on data from many sources, most of them listed in the References.

It has been prepared as part of the work done in the world survey of the living aquatic resources which is being made by the Biology Branch of the Fisheries Division, F.A.O. (For information on the work in the world survey of living aquatic resources, see the attached "Note on the F.A.O. Programme in connection with Living Aquatic Resources, with Special Reference to the Compilation of Data on Species of Economic Importance").

This is the first draft of what is intended to be a cumulative repository of data on the biology of the Tench *(Tinca tinca)*, to be revised as further information becomes available. The co-operation of the freshwater fisheries biologists and fish culturists is earnestly requested in the revision and development of this synopsis. Criticism of this study and comment on its usefulness will be welcome.

FAO/58/2/951

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A SYNOPSIS OF BIOLOGICAL DATA ON TENCH

Tinca tinca (Linnaeus, 1758)

1. IDENTITY

1.1 Taxonomy

- *Definition*

Phylum VERTEBRATA
Subphylum Craniata
Superclass Gnathostomata
Series Pisces
Class Teleostomi
Subclass Actinopterygii
Order Cypriniformes
Division Cyprini
Suborder Cyprinoidei
Family Cyprinidae
Genus *Tinca* Cuvier 1817
Species *Tinca tinca* (Linnaeus 1758).

- *Description*

Genus *Tinca* Cuvier 1817

"Scales small, deeply imbedded in the thick skin; lateral line complete. Dorsal fin short, without spine, its origin being opposite the ventral fin; anal short; caudal subtruncated. Mouth anterior; jaws with the lips moderately developed; a barbel at the angle of the mouth. Gillrakers short, lanceolate; pseudobranchiae rudimentary. Pharyngeal teeth 4 or 5-5, cuneiform, slightly hooked at the end," Günther (1868).

Tinca tinca (Linnaeus 1758).

"Body about four times as long as high. Its head varies in length, and may be a little longer than the height of the body, or a little shorter. The thickness of the fish is about one-half its height, but all measurements vary with age and sex. The diameter of the eye is about one-sixth of the length of the head. The eye is one-and-a-half times its own diameter behind the extremity of the snout, and distant two-and-a-half diameters from the eye on the other side of the head. The nasal apertures are midway between the orbital ring and the extremity of the snout. The mouth is rather small; it opens at the extremity of the snout, and its hinder angles incline upwards under the nares. The jaws are equal, the lips fleshy, and the small barbels have a length equal to one-half the diameter of the eye.

"The contour of the body ascends in an even, moderate curve from the snout to the dorsal fin, with a slight

indentation in the occipital region, which is, however, more marked in males. The height of the tail may be equal to half the greatest height of the fish.

"All the fins are rounded. The dorsal fin is rather nearer to the end of the tail than to the snout; its first ray is rudimentary, and is counted as an osseous ray by (some authors) but is ignored by Günther; the second ray is imperfectly developed. The longest rays of this fin are equal to two-thirds of the height of the body. The anal fin is not close to the vent, it is as deep as the tail, and as long as the pectoral fin. The fifth and sixth rays are the longest. The ventral fins are a little in advance of the beginning of the dorsal; the first two rays are often rudimentary; sometimes the fin is as deep as the dorsal is high; but the depth varies with sex. At first, according to Von Siebold, the fins are alike in male and female, but after development of the reproductive organs has taken place, the first ray becomes thick in the male and very thin in the female. These fins reach back to the vent. The pectoral fins have thinner rays, the first scarcely stronger than the others; the longest are the fourth to sixth, and they do not reach to the ventrals. The longest rays of the tail fin are almost equal to those of the dorsal fin; the tail is evenly rounded, with a very slight emargination.

"The scales are much longer than they appear to be, for only their extremities are seen while they are still attached to the fish. They are narrow, rounded at both extremities, marked with numerous striae, which radiate longitudinally from a point near the base. The concentric striae are very wavy, and arranged round the basal point. The lateral line at first descends in a curve from the operculum as far as the middle of the body, and is then prolonged in a straight median line to the middle of the tail. The mucus-canals are short and cylindrical. The mucus-canal system of the head is well developed, with numerous pores. There are 23 or 24 of these apertures on the pre-operculum and lower jaw. They are even more abundant on the sub-orbital ring, and not less numerous on the anastomosing branches of the frontal and occipital region. The secretion of mucus from these canals and the lateral line is so great that it forms a thick stratum over the body and renders the tench as slippery as an eel.

"The colour of the tench varies with the water. When it lives in muddy water its colours are dull; but when found in clear water the fish is often brilliant. Its common tint is a dark olive-green, shading into black, with a remarkable transparent brassy glitter. The colour is paler on the sides, and on the belly becomes greyish-white. The fins are colourless, reddish-brown, or violet, their colours, like those of the fish, varying with the conditions of existence. The commonest type is the brightly coloured one with the dull golden glimmer". Seeley (1886).

The Tasmanian (Australia) tench has "often a yellowish or golden belly, the fins sometimes more or less orange, while the throat is creamy. Colouration is dependent on background. Where shade and cover are available (as in nature) the colours are as above, but where the water is turbid and shadeless, as in dams, the body colour is pale golden and the fins orange". Weatherley (1957).

"The females are distinguished from the males by far weaker and shorter ventral fins and weaker pelvic bones". Schaeperclaus (1933).

(For meristic characterics see 1.3 General variability - *Subspecific fragmentation).*

1.2 Nomenclature

- *Valid scientific name*

Tinca tinca (Linnaeus 1758)

- *Synonymy*

(i) *Cyprinus tinca* Linnaeus
(ii) *Tinca vulgaris* Cuvier
(iii) *Tinca aurata* Cuvier
(iv) *Tinca chrysitis* Agassiz
(v) *Tinca italica* Bonaparte
(vi) *Tinca vulgaris*, var. *maculata* Costa
(vii) *Leuciscus tinca* Günther
(viii) *Cyprinus tinca auratus* Boulenger

- *Standard common names, Vernacular names*

Country	Standard Common Names	Vernacular Names
Australia	Tench	
Belgium	Tinche (French) Laauw (Flemish)	Tiche, Tinque
Bulgaria	Lin	
Chile	Tenca	
Denmark	Suder	Schomackore
Finland	Suutari	Tuutain
France	Tanche	Tiche, Tinche, Tinque, Tanco, Tenco, Tinco Aiguillon (fry)
Germany	Schleie	
Greece	Ghlíni	Tínki
India	Tench	
Italy	Tinca	
Ireland	Tench	Lis, Lios
Netherlands	Zeelt	Lauw, Tink, Lapper, Muilhond
Norway	Suter	
Poland	Lin	
Portugal	Tenca	Godião
Rumania	Lin	
Spain	Tenca	
Sweden	Sutare	Lindare, Skomakare
Switzerland		Schleie (German)
Turkey	Kaya baliği	Tatli su
Union of South Africa	Tench, Seelt	
United Kingdom	Tench	Golden Tench
United States	Tench	
U.S.S.R.	Linj	
Yugoslavia	Linjak	

1.3 General variability

- *Subspecific fragmentation (races, varieties, hybrids)*

Meristic counts

Meristic counts have been given by different authors in several countries, as indicated in the following table.

Organs	Meristic Counts Ranges					
	AUSTRALIA (TASMANIA)	UNITED KINGDOM	EUROPE	EUROPE	PORTUGAL	U.S.S.R.
	Weatherley (1957)	Weatherley (1957)	Günther (1868)	Seeley (1886)	Albuquerque (1954-1956)	Berg, Bogdonov, Koshchin, Rass (1949)
Dorsal fin	11-13	11-12	11-12	11-12	IV+8-9	III-IV+8-9
R.pectoral fin 1/	17-19	17-19	-	15-17	I+15-18	
L.pectoral fin	17-20	15-19	-			
R.ventral fin	9-11	9-12	10-11	10-11	II+8-9	
L.ventral fin	9-12	9-11				
Anal fin	10-12	10-11	9-10	9-10	III-IV+7-8	III-IV+6-8
Caudal fin	-	-	-	19	-	
R.lat.line	90-105	97-106	90-105	-	96-120	87-115
L.lat.line	91-105	93-108				
R.trans.line	27-36 / 18-23	30-35 / 21-24	30-32 / 18-22	32-33 / 18-25	30-32 / 18-22	30-35 / 19-23
L.trans.line	27-35 / 17-24	31-35 / 20-24				
Vertebrae	21-24 / 16-18	21-24 / 16-19	22-18			37-41
Pharyngeal Teeth	4(5)-3(6)	-	4(5)-5			4-5

1/ R = Right
L = Left

Weatherley (1957) compared fin ray, scale and vertebral counts and numbers of pharyngeal teeth of 46 specimens from Tasmania of the Coal River and Lake Tiberias, 11 specimens from England and Scotland, and the values given by Günther (1868) (see table above). He found that the three sets of values

differed, the Tasmanian and British specimens having a greater range for most taxonomic features than the values given by Günther. He thought a possible significant difference between the Tasmanian and British fish was the number of scales in the transverse line above the lateral line; a proportion of the Tasmanian fish had less than 30 scales while the British fish had 30 or more.

- *Varieties*

The variety *(aurata)* was developed in Bohemia and Silesia through careful crossings. Its colour is bright yellow mixed with orange tones and dotted with vivid black spots. It is smaller and a common and valuable aquarium species.

Several varieties seem to have been developed by crossings by fish culturists (see 5.6 Fish farming, transplanting and other intervention).

- *Genetic data (chromosome number, protein specificity)*

(Information not yet found).

2. DISTRIBUTION

2.1 Delimitation of the total area of distribution and ecological characterization of this area

- Europe and Asia Minor

This is a European species distributed in every European country including the United Kingdom, in small streams or marshy waters, large and small rivers, brackish waters and lakes, with the exception of the northernmost areas such as Iceland and northern Norway, Finland and Faroe Islands. In the east, reaches across Western Siberia and Turkey. Avoids very cold or warm waters.

In the United Kingdom, is found as far north as Loch Lomond in Scotland. Jenkins (1950); was planted in some southern lakes of Norway about one hundred years ago; is found in the eastern side of the middle and southern sections of Sweden, and was also introduced in some northern lakes about one hundred years ago; is found in the south of Finland. Andersson (1942).

- U.S.S.R.

In the U.S.S.R. is found in the north in the Kola Peninsular, Baltic Sea and Finnish Gulf drainages; in the south in the Caspian and Black Sea drainages (but not in the Crimea) up to the Ural and Emba rivers; in Siberia in the Ob and Yenisei river basins. Berg, Bogdonov, Koshchin and Rass (1949).

(See also Figure 1).

Transplanting

Africa

In the Union of South Africa the first attempt, 1896, of introduction was apparently unsuccessful. Further attempts in 1910 and 1911 were successful and, although it cannot be said to have achieved much popularity, it has done very well in some instances including as forage fish for largemouth bass in certain types of water.

Introduced in Morocco.

America, North

Was introduced in the United States sometime during the last century and is to-day found in several parts of the country, e.g. in the States of Connecticut and New York, on the East coast. On the West coast the first known introduction into the North West was planting made in the States of Washington and Oregon in 1895. Is now found in the Columbia River, in certain streams and lakes of the Puget Sound drainage and on Vancouver Island (Canada). Chapman (1942). In California the original specimens were brought from Italy in 1922, and have since then been gradually spread in reservoirs throughout large parts of Santa Cruz and San Mateo countries. Shapovalov (1944).

America, South and Central

In Chile, where introduced, is occasionally found in the central area of the country. Mann (1954). Has probably been also introduced into other Latin American countries.

Asia

In India was introduced about 1870 into the Ootacamund Lakes and subsequently transplanted to other ponds and lakes in the Nilgiris and the Shevaroy. Hills, Jones and Sarojun (1952).

In Israel introduction has had little success so far. Hofstede (1955).

In 1929 was introduced in Indonesia; was widespread in West Java, but is at present scarce. Also introduced in Japan.

Oceania

Was introduced in Australia, Tasmania, during the latter part of the last century where is found to-day in the Clyde, South Esk, Jordan, Meander, Coal rivers, and in the Macquarie and Tiberias Lakes. Weatherley (1957). In 1876 was widely distributed in Victorian streams. Roughley (1951). Also found in New South Wales. Introduced also in New Zealand.

(See also Figure 1).

2.2 Differential distribution

- *Areas occupied by eggs, larvae and other junior stages; annual variations in these patterns, and seasonal variations for stages persisting over two or more seasons.*
- *Areas occupied by adult stages: seasonal and annual variations of these.*

Deposits the eggs near the banks of ponds, lakes or rivers, which may fall to the bottom, but are normally attached to water weeds, preferably *Potamogeton*, sometimes called 'Tench wood'.

Spends much of its life on the bottom or among the vegetation of lakes and margins of rivers, avoiding bright light. In the winter it burrows into the mud for protection against cold, and passes the season in a motionless condition closely approaching hibernation. Seeley (1886).

Prefers rivers of slow current and warmer waters, creeks, river banks and marshy lakes and ponds. Also found in brackish waters (in the BalticSea) and in high mountain lakes, living as high as 1650 m. above sea level, in lakes of the Alps. Heuschmann (1939), et al.

2.3 Behaviouristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution

One of the only two species of Cyprinoids widely distributed in northern and southern Europe. Its wide distribution and successful transplantation to many parts of the world is probably due to its physiological robustness; it can live in comfort within a temperature range of 15.6°C. to 32.2°C. and, being a sluggish fish, tolerates low oxygen values much better than other more active forms - it can live comfortably in waters whose low oxygen content would quickly kill other fish.

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

- *Sexuality (hermaphroditism, heterosexuality, intersexuality)*

Heterosexual.

- *Maturity*

The average specimens mature and spawn in captivity during the third year at a length of 20 to 30 cm. and a weight of 250 to 375 gr. Huet (1953).

In captivity three-year-old tench may spawn even if scarcely 9 cm. long and weighing only 15 gr. Schaeperclaus (1933).

In Russia, matures during third to fourth year. Berg, Bogdonov, Koshchin and Rass (1949).

- *Mating (monogamous, polygamous, promiscuous)*

Polygamous.

Two males at least attend one female. Seeley (1886).

- *Fertilization (internal, external)*

External.

- *Fecundity*

- *Relation of gonad size and egg number to body size and to age*

Females produce about 175,000 to 300,000 eggs for each pound of weight.

- *Coefficient of fecundity*

(Information not yet found).

- *Spawning*

- *Spawning seasons (beginning, end, peak)*

Countries	Season	
	Beginning	End
France	June	July
Germany**	June	July
Spain	June	July
Sweden	June	July
United Kingdom*	April-May	August
U.S.S.R.	Mid-May	Mid-July

* One of the latest spawners of British freshwater fish. Jenkins (1950).

** Some sources report that it spawns already in May and April, and even in March, but these cases are very rare and maybe happen only under extraordinarily favourable conditions. Heuschmann (1939).

- *Number of spawnings per year, frequency*

Spawning is not continuous, but takes place gradually with several intervals. Jenkins (1950).

- *Spawning time of the day*

(Information not yet found).

- *Induction of spawning*

Gerbil'skii (1938) as listed by Pickford and Atz (1957) gave an intracranial injection of four fresh glands of *Carassius carassius*

in females, at the time when 10% of control females matured, with the result that seven out of twelve matured.

Kazanskii (1940) as also listed by Pickford and Atz (1957) gave intracranial or intramuscular injections of four glands of *Carassius carassius* in females, while controls matured, 26 out of 30 injected matured.

- *Spawning grounds*

- *Coastal (surface, vegetation, shore, shoal, sand, shelter);*

- *bottom.*

An idle fish spending much of its life on the bottom, but towards the spawning season, if temperature conditions are favourable, it schools at the surface playing love games, jumping above the water, and emitting sounds as though smacking the lips.

It prefers spawning in shallow shore waters of which the bottom is thickly covered by water-weeds to which the eggs are attached. Spawning, however can also take place in deeper waters if the aquatic vegetation reaches to near the surface of the water. Heuschmann (1939). Spawning takes place at a water temperature of 18-20°C. or higher.

- *Eggs - structure, size, hatching type, parasites and predators*

- *Structure, size*

The eggs are small (1 - 1,2 mm.) adhesive, yellow or greenish.

- *Parasites and predators*

(See 3.2 Larval history - *Parasites and predators)*

3.2 Larval history

- *Account of embryonic and juvenile life (prolarva, larva, postlarva, juvenile).*

- *Feeding*

The food is extraordinarily similar to that of carps.

Most carp below 2.5 cm., with the yolk sac not completely absorbed, feed on plankton and bottom animals and vegetation. Carp fry are primarily small-animal eaters rather than plant eaters. They feed mainly on insect larvae and shore cladocera. They are ainly shore animal eaters rather than plankton feeders which they eat only in an emergency. Schaeperclaus (1933).

- *Rates of: development and survival*

'The embryonic development lasts from three to seven days at a water temperature of 22° to 24°C.

'The length of the larvae at hatching in June is 1 to 1,2 mm.

and the weight 0,9 to 1,2 gr; in December of the same year they have grown to a length of 3,8 to 4,1 mm. and a weight of 1,3 to 3 gr.

'A twelve-day old larva reaches the length of 8 to 10 mm.' Berg, Bogdonov, Koshchin and Rass (1949).

- *Periods of: development and survival.*

(Information not yet found).

- *Parental care*

(Information not yet found).

- *Parasites and predators*

- *Parasites*

The microscopic suck worms *Gyrodactylus* and *Dactylogyrus* are two of the worst enemies of the broods, mainly in over-crowded ponds where the fish is usually undernourished. They can wipe out entire broods.

The unicelular skin and gill parasites *Chilodon* and *Ichthyophthirius* often attach and destroy young or older fish if crowded in small ponds. Heuschmann (1939).

Large mortalities can also be caused during the autumn among the young fish by the sporozoa *Sphärospora tincae*.

- *Predators*

The main enemies of the young are the larvae of swimming beetles and dragonflies, water scorpions, water bugs(Hemiptera); among the vertebrates the green water frog (*Rana esculenta*) and the three-pointed stickleback when in large numbers.

3.3 Adult history

- *Longevity*

Lives up to about ten years.

- *Hardiness*

Can exist in water which contains the minutest quantity of oxygen. Does not show any special preference for any water, living even in sewage water, and it is not seldom that in nature is found in iced muddy water, and may exist during the summer in the dried-up mud of ponds.

Its capacity of living with a minimum of oxygen can probably be surpassed only by the gold fish (*Carassius vulgaris*). Heuschmann (1939).

In eastern parts of England is brought to market and if not sold put back into water. Seeley (1886).

In the winter can be shipped alive in boxes with weeds and moss.

- *Competitors*

Competes for food with carp, bream and cruscian carp.

- *Predators*

Perch pike and eels which eat the smaller fish in large numbers.

- *Parasites and diseases*

By far the worst enemy is the copepod *(Ergasilus sieboldi)* which is only a few milimeters long and parasitises the gills of fish. It has depopulated several good tench waters. Heuschmann (1939).

The protozoan *Costa necatrix* causes sliminess of the skin and attacks the gills as well. The gills are also attacked by sporozoans such as *Myxobolus piriformis* and *M. ellipsoideus*.

Virus and bacterium *(Pseudomonas punctata)* infection causes dropsy disease.

Red pest may be caused by varieties of *Pseudomonas putida* such as *Pseudomonas putida* forma *cyprinicida* and *Pseudomonas putida* forma *Davidi*.

The skin of the belly of fish infected by such disease shows a dark red colour. The ventral and anal fins, and the lower part of the tail, may also be red-coloured, and the gills show hemorrhages and necrotic places. The reddening of the skin is caused partly by abnormal widening of the blood vessels and partly by hemorrhages in the skin. Van Duijn (1956).

3.4 Nutrition and growth

- *Feeding (time, place, manner, season)*

Seeks its food by night, depending on the senses of smell and taste for food finding. It is a typical shore and bottom life feeder. It practically hibernates from late autumn to early spring when it burrows into the mud and does not feed. 'It enters the mud, fat, in the late autumn, and reappears thin, with the abdomen flat, in the spring". Seeley (1886).

- *Food (type, volume)*

It is an erroneous belief that this fish requires natural food, differing from that of carp, and that it feeds on the dejecta of carp. Examination of Tench from carp ponds showed very little difference in their type of food. It is therefore a food competitor of carp. Schaeperclaus (1933).

The preferred food in Europe are small molluscs specially *Bithynia tentaculata* and *Valata piscinalis*. Other sources of food are the animal life of the shore vegetation or of the bottom of rivers and lakes such as insect larvae, primarily of Chrionomidae, worms, and planktonic animals like daphnia and others.

In Australia, Tasmania, Weatherley (1957) found the organisms listed below in the guts of a total of 216 specimens, confirming the earlier reports.

Lake Tiberias	Two Farm Dams	One Farm Dam	Hatchery Pond
Length of Fish 2.3-over 20 cm.	Length of Fish 12.6-31.7 cm.	Length of Fish 12.6-31.7 cm.	
Algae - 1/	Chironomidae XX	Pulmonata XX	*Oedogonium sp.* XX
Copepoda XX 2/	Oligochaeta X	Eulamell-ibranchiata X	*Tabellaria sp.* X
Cladocera XX	Coleoptera -	Coleoptera -	Gomphonomataceae X
Amphipoda XX	Odonata -	Odonata -	
Ephemeroptera XX	Trichoptera -	Chironomidae -	Desmidiaceae X
Odonata XX	Ostracoda -	Trichoptera -	Other algae -
Chironomidae X		Copepoda -	*Potamogeton* X
Mollusca X		Amphipoda -	
Arachnida X			
Oligochaeta X			

1/ - unimportant; X less important; XX very important.

2/ 'Copepoda, Cladocera and Amphipoda were the most important food to fish less than 6 cm. long, though they also took some small Chironomidae; above this length aquatic insects, mainly Ephemeroptera and Odonata, occupied by far the biggest volume, though Chironomidae were most numerous'. Weatherley (1957).

Weatherley (1957) also conducted experiments feeding different lots of fish with ground cooked ox liver, rooted aquatic plant *Ranunculus trichophyllus, Myriophyllum elatinoides* and a sedge (probably *Schoenus fluitans),* and found that the fish did not eat the plants showing that they cannot utilise higher plants directly as food.

From his observations, Weatherley (1957) concluded that tench seems to be a carnivorous feeder although it can feed on algae if animal feeding is not available.

- *Relative and absolute growth patterns and rates;*

- *Average and maximum growth*

The average size of tench is between 15 to 30 cm., and the average weight from 250 to 1,000 gr. It may grow in natural waters to 50 or even 70 cm. long, weighing from 4 to even 8 kilos. Such maximum sizes are reached only after several years. Heuschmann (1939).

(For growth under culture see 5.6 Fish farming, transplanting and other intervention).

- *Absolute growth*

U.S.S.R. Berg, Bogdonov, Koshchin and Rass (1949).

Age (Years)	Lake of Chebarkul (Cheliabinsk region) 1941		Lower Volga 1940
	Length (excluding caudal fin) cm.	Weight gr.	Length (excluding caudal fin) cm.
1	-	-	13,6
2	15,8 - 18,6	60 - 96	21,6
3	-	-	25,7
4	25,7 - 26,1	285 - 307	27,5
5	29,6	545	-
7	35,3	825	-
8	35,9	855	-

Weatherley (1957) calculated growth rate by back-calculation from scales. Three scales were taken at random from each fish and their means were plotted against fish lengths. The relation was rectilinear.

That author estimated age from marks on the scales of tench from Coal River and Lake Tiberias. 'Scales were removed from an area anterior to the dorsal fin, mid-way between the dorsal mid-line and lateral line'. Data of the Coal River were derived from the scales of 263 fish, and of Lake Tiberias from scales of 257 fish. The approximate results of the study are given in the tables below, read from the growth curves given.

COAL RIVER

Year Class	Age 1/							
	1	2	3	4	5	6	7	8
1944-5	2.6	5.2	8.9	13.0	16.9	21.0	23.0	27.9
1945-6	2.8	5.2	8.8	11.9	16.0	20.0	22.8	24.3
1946-7	3.0	5.4	8.6	13.3	18.0	21.3	23.8	
1947-8	3.0	5.6	9.7	13.7	18.0	21.2		
1948-9	3.0	5.8	10.1	14.0	17.0			
1949-50	3.0	6.0	10.0	12.8				
1950-1	2.8	6.0	8.9					

LAKE TIBERIAS

Year Class	Age					
	1	2	3	4	5	6
1947-8	2.7	4.8	6.5	9.2	11.7	13.4
1948-9	2.8	4.9	7.3	9.7	12.8	
1949-50	3.0	5.4	8.0	10.4		
1950-51	2.0	5.4				
1951-2	3.0	5.5	7.4			
1952-3	3.3	5.8				
1953-4	3.2	4.8				
1954-5	2.9					

1/ Length is given in cm.

-- *Relation of growth to feeding, to other activities and to environmental factors.*

Houschmann (1939) gave the results, copied in the table below, of experiments in ponds conducted to evaluate the relation of different amounts of feeding and size of the stocks with growth (weight), using two summers-old, one-year-old, tench:

Number of Pond	Amount of food per Hectare (kg.)	Number of T2 [3] stocked per Hectare	Number of T3 fished per Hectare	Individual growth of T2. (gr.)	Growth per Hectare (kg).	Relative food coefficient.	Absolute food coefficient.
A. Use of increase amount of food compared with a corresponding increase of stock							
99	375 L [2]	1750	1735	89	155	4.5	28,8
97	750	3500	3445	58	199	5.8	13.2
41	1320	3960	3894	55	213	9,3	18,6
42	2640	7920	7722	61	466	6,7	8,1
43	5280	15840	14058	41	576	10,4	12,2
B. Use of half, whole and double amounts of food by the same size stock							
46 [1]	660	3960	3432	52	178	6,2	18,3
41	1320	3960	3894	55	213	9,3	18,6
44	2640	3960	3894	60	232	15,1	25,3
C. Use of equal amounts of food for a unit size stock and its double							
44	2640	3960	3894	60	232	15,1	25,3
42	2640	7920	7722	61	466	6,7	8.1
D. Maize feeding							
45	1320	3960	3828	54	207	9,7	20,3
E. Unfed							
47	Unfed	3960	3828	16	62	-	-
49	"	7920	7392	2,5	15	-	-
50	"	15840	13332	-9	-112	-	-

1/ The fish stocked in all the ponds weighted originally 80 to 90 gr., except for pond 46 in which they weighted only 50gr.

2/ The fish in pond 45 were fed with maize and in all the others with lupine, except for ponds 47, 49 and 50 in which they were not fed.

3/ T2 = two-year-old specimens
T3 = three-year-old specimens.

Pardo Garcia (1951) listed the data tabulated below, compiled from several sources, on absolute increase in weight under different environments.

Age (Years)	Ponds			Abundant feeding.
	1st quality	2nd quality	3rd quality	
	Weight (gr.)			
1	17	10-14	10	120-130
2	80	60	50	300-350
3	320-350	285	205	700-1000
4	500-600	410	335	-

Growth depends largely on living conditions; in the lake of Ubinsk in Western Siberia it reaches when five years old the length of 19,2 cm., and a weight of 191 gr., in the Liban Lake, at ten years of age it reaches a length of 46.5 cm. and a weight of 1,49 kg., Berg, Bogdonov, Koshchin and Rass (1949).

- *Condition factor*

Schaeperclaus (1933) found as coefficient of condition for European tench as 1.3, and developed function P for the values K = 1.3 for tench, 1.8 for normal Galician carp and 1.1 for rainbow trout of total lengths (from point of head to longest point of tail) from 5 to 25 cm., the fish being normally fed as shown in Figure 2.

Weatherley (1957) calculated values of Condition Factor of tench in Lake Tiberias and Coal River. Condition (K) was assessed as $K = \frac{W10^2}{L3}$.

He found a considerable range in condition for tench in Lake Tiberias and that condition tended to increase with fish length up to 15 cm. or more. In plotting depth, breadth, against length, Weatherley found both directly proportional and linearly related to length.

The same author concluded from visual comparisons of a number of tench that "it appears unlikely that any other of the dimensions of the body bear a significantly non-linear relation to length; it is probably safe to say that the tench does not change its body form much throughout life, especially over the size range encountered here" (Lake Tiberias).

For tench of the Coal River, Weatherley (1957) plotted condition factors of fish 20 to 30 cm. long against the dates of their captures, and found that condition appeared to rise from a mean low of about 1.5 to a mean high of about 1.7 to 1.8 in midsummer, with a decline corresponding with spawning time.

3.5 Behaviour

- *Migration and local movements*

An indolent fish passing much of its life idle on the bottom among the water vegetation; spends winter in a motionless condition. Can, however, on an emergency, move very rapidly. It becomes more active during the spawning season, coming to the surface.

- *Schooling*

Weatherley (1957) made many observations of tench in ponds and troughs and observed "that they aggregate in shade during the hours of daylight". The aggregations could be dissolved by illuminating the water uniformly and eliminating all shade, though they formed again on re-introduction of shade into the system. When a school aggregate moved it endeavoured to remain in shade, and schooling was preserved when the fish moved around obstacles; here, the larger fish generally assumed the leading role and maintained steadier orientation. As the light faded in the evening the schools dissolved. At night, or during the day if the trought was covered, the schools remained dispersed, the fish moving independently of each other".

The same author wrote that "in contrast to the normal habit of schooling, small tench have been seen swimming openly and independently in bright light, both in the laboratory and the field. Moreover, large tench have been seen during spawning swimming freely at the surface in bright sunlight, disregarding shade and cover".

Weatherley (1957) thought that the usual negative phototropism of tench could have survival value in nature.

- *Reproductive habits*

(See 3.5 Behaviour - *Migration and local movements).*

- *Physiology*

Weatherley (1957) conducted aquarium experiments to determine lethal temperatures with specimens ranging from 2.7 to 27.5 cm. in length. He found that the temperatures were much higher in summer than winter.

He also found that the first sign of disablement was slight loss of balance and co-ordination. After an initial display of discomfort the tench loses lateral stability and swimming co-ordination, tending to swim head downwards. It darts spasmodically and sometimes violently around its tank before finally sinking on its side to the bottom, twitching occasionally.

The same author wrote that the highest concentration found causing death of the tench at 16°C, was about 0.4 p.p.m.

To determine the tolderance of the fish of high concentration of carbon dioxide, tench was exposed to high concentrations of carbon dioxide in combination with low concentrations of oxygen in live-boxes in a plant filled farm dam, one at the surface and one at the bottom. The values of carbon dioxide at the bottom over 24 hr. ranged from 20 to 43 p.p.m. (mean 33 p.p.m.); oxygen remained close to a mean of 1.7 p.p.m. Carbon dioxide values and oxygen where at the surface, rather lower and higher respectively. The fish were left in the dam for 11 days and only one from the bottom box died. In this box, however, they all showed discomfort. The mean temperatures during the experiment were close to 15.6°C (surface) and 14.9°C (bottom).

Salinity tolerance experiments made by Weatherley (1957) showed that salinity of 15.4°/oo was lethal in 24 hours, and survival

possible at 13.8°/oo and less, but the fish became completely disabled. In further experiments done in a galvanized iron tank, 1.2 m.sq. and 0.6 m. deep, painted inside with chemically-inert plastic, eight fish were exposed to a salinity of 10.75°/oo and survived unaffected for some 37 days while evaporation caused salinity to increase to 14.58 gr. °/oo.

The approximate highest salinity tolerated for 24 hours without ill effects, exposed directly without previous acclimatization as found by Weatherley (1957) was 12.5°/oo.

Tench lives in the Derwent river estuary (Tasmania) at surface salinity of 3.8°/oo (summer ebb tide) and 9.96°/oo (winter flow). On the coast of Finland in the Baltic Sea where the coastal salinities are mostly between 5 and 6°/oo, is commercially caught together with other fresh water species. Weatherley (1957).

From his experiments and the occurrences of tench in natural brackish waters, that author concluded that the salinity tolerance of the species is "above average (14.6°/oo) though not exceptional for a freshwater fish".

The following information on the physiology of tench has been found in the available literature:

Brown (1957):-

- Percent Hemoglobin in Whole Blood: 2.36 - 3.78
- Percentage Oxygen Saturation of Blood in Dorsal Aorta or Caudal Artery: 85
- (Gills perfused with aerated water)

Spector (1956):-

- Heart Rates: 31 to 42 beats/min.
- Galvanotaxis and oscillotaxis: Anodal galvanotaxis (AG)
- Absorptive maximum of visual pigments: .512 mm.

Dottrens and Burnand (1952):-

Those authors stated that the preservation of fish in ponds, tanks or aquariums is subject to four interdependent factors which regulate their metabolism: flow of water, temperature, water oxygenation and light. They listed the following values required by tench:

Flow of water (1/min)	1/4
Temperature (°C) - maximum	+ 18°
- normal	+ 15°
Oxygen (cm^3/1.) - minimum	3 1/
- normal	5
Light (0 - darkness; 10 day light)	7

1/ Tench, being extremely resistant, requires a normal rate of oxygen of 4 and a minimum of 1,5.

Lindstedt (1904):-

Calculated the total caloric needs of tench upon one square diameter surface, per hour, and for a temperature of 15 degrees centigrade to be of approximately 10 gram-calories.

"Great faith was placed in older times to the healing powers of the thick slime covering the body of tench which was said to act as a sort of balsam for fish and human diseases. This belief is now discredited". Norman (1937).

4. POPULATION (STOCK)

4.1 Structure

- *Sex ratio*

Wohlgemuth (1921) as quoted by Heuschmann (1939) examined a sample of 191 specimens of which 84 were females and 107 males. He roughly calculated that the sex ratio based on this observation must be approximately 50:50.

- *Age composition*

(No information has yet been found on age composition or size composition in natural waters or on 4.2 to 4.5; some information is given under 3.4 Nutrition and growth, and 5.6 Fish farming, transplanting and other intervention on stocks in ponds).

- *Size composition*

4.2 Size and density

- *Average size*
- *Changes in size*
- *Average density*
- *Changes in density*

4.3 Natality and Recruitment

- *Natality*
- *Natality rates*

4.4 Mortality, morbidity

- *Rates of mortality*
- *Factors or conditions affecting mortality*
- *Factors or conditions affecting morbidity*
- *Relation of morbidity to mortality rates*

4.5 Dynamics of population

4.6 Relation of population to community and ecosystem, biological production, etc.

(See 5.6 Fish farming, transplanting and other intervention).

5. EXPLOITATION

5.1 Fishing equipment

- *Fishing gear*

Caught with the rod, nets (different kinds of nets such as drag nets are used and commonly the fish is caught while fishing for others, in Australia the gill net is the most effective means of capturing it) and traps (bow net or weir vasket, and hoop net).

- *Fishing craft*

Small open deck boats or canoes used on river and lake fishing

5.2 Fishing areas

- *General geographic distribution*

Caught all over its area of distribution not only in the small sluggish streams, but in rivers and primarily in lakes, deltas, and in the Baltic Sea in brackish water basins.

- *Geographical ranges (latitudes, distances from coast, etc)*

Caught in most waters except for very cold or warm ones.

- *Depth ranges*

Caught at all depths depending on the type of fishing gear used.

5.3 Fishing seasons

- *General pattern of fishing season*

(See *Dates of beginning, peak and end of season*).

- *Duration of fishing season*

Spring and summer

- *Dates of beginning, peak and end of season*

The best period for fishing is from May to October. Usually, however, ponds and lakes are drained during the winter and spring, when tench is not yet active, so that it can be fished out easily.

- *Catches*

No separate tench catch statistics are usually recorded and the quantities given here were taken from Berg, Bogdanov, Koshchin and Rass (1949).

In the U.S.S.R. the largest catches are made in the delta regions, ditches and lakes.

In 1913 2,80 m.t. were caught in the delta of the Volga River; in the Ilmen Lake group (Cheliabinsk region, Transural chain), the yearly catch in 1934-39 was of 5 to 10 m.t.; in the Baltic Sea basin in the Kurish Haf and Frish Haf gulfs the catch in 1937-38 was of 11,5 to 14 m.t.; in Latvia in 1938 was of 40 m.t.

In Rumania 0,32 m.t. were caught in 1936-38; in Czechoslovakia 0,06 to 0,09 m.t. and in Turkey up to 0,15 m.t. (1923).

For Poland the following statistics were made available, in metric tons:

1952	1953	1954	1955	1956
27.4	27.0	22.7	27.3	37.4

In Australia the freshwater fisheries of Victoria are based mainly on catches of English perch and tench, the latter species being caught in lakes, swamps and in the London River and its tributaries. Roughley (1951).

The following production statistics have been extracted from Fisheries Newsletter of Australia:-

1951-52	1952-53	1953-54	1954-55	1955-56
15.8	17.8	14.5	18.4	16.4

5.5 Fisheries regulations

(Information not yet found).

5.6 Fish farming, transplanting and other intervention

Until the beginning of the century was considered in Europe a very poor quality fish, but with the shortage of better edible fish such as trout, it was introduced by restaurateurs and is at present a rather popular fish. It consists together with carp and trout the reliable source of edible freswater fish.

Seldom cultivated alone by fish culturists; the common practice is to breed it together with carp.

The flesh is finer than carp, but it grows much slower. It supports cooler waters with lower oxygen content than carp. It is convenient for stocking of weedy marshy ponds as well as for waters not easily renewable. it requires ponds with abundant natural food. Breeding of tench is useful for stocking of lakes and running waters. Huet (1953).

The difficulty of raising tench with carp is its ability to easily propogate and the large size of its spawn aggravated by its slow growth.

The following methods are described by Huet (1953) for the production of first year tench:-

(a) Production of fry in one phase

Reproducers are placed in second year carp ponds or in fatting ponds where they spawn. To avoid overproduction only one female per hectare should be placed in the pond. Upon reaching a length of 3 to 5 cm. the fry is taken out by gradually draining the pond and collecting the fry as they come out with the outflow water in boxes or nets. The catching boxes should be left overnight and some water led through the pond, so that the remaining fry will swim towards the box.

This system is required due to the great difficulty in catching the fry which are buried in the mud.

(b) Production of fry in two phases

Several reproducers (4 to 6 females and 8 to 12 males per $\frac{1}{4}$ of hectare) are placed in ponds of first stocking for carp or in special ponds. The ponds are emptied at the end of August and the fry measuring about 3 cm. are poured in ponds for young tench where they remain until the next spring, avoiding in this way the autumn drainage damaging to such young fish. Huet (1953).

Tench is a slow grower, and one of the important aims of its culture is to obtain races of faster growth practicing systematic breeding of rapid growing races according to the same selective methods used for carp.

It is not advisable to rear it more than three years old because of its excessive spawning in the fatting ponds. If four-year-old tench is cultivated the sexes should be separated to avoid further spawning.

No conclusive judgement could be formed on the value of rearing tench as secondary stock in carp ponds; it could be of different character in individual ponds in accordance with local conditions. Since the food of the tench is practically the same as that of the carp, the advantage of secondary stock lies only in the increase of fish stock density which could be obtained by the addition of small carps. Schaeperclaus (1933).

That same author recommended that an increase in number of tench must be followed by a decrease in number of carp, or the individual growth of carp will be considerably affected. Practice has shown that to a certain number of two-year-old carps not more than an equal number of two-year-old tench should be added. Good results have been achieved by placing

only half as many tench as carp, buth of the two-year-old class. To yearling carps there should be added not more than 100 to 200 per cent of yearling tench to allow a satisfactory individual growth of both species.

Huet (1953) gave the following rates .100 to 200 per cent of second year tench to be added to ponds with carp of the same age; half or the same number of three-year-old tench to be added to ponds of carp of the same age; in ponds of first year carp tench should not be added.

The best marketable tench weights 1/3 to ½ lb., which are usually three years old under ordinary breeding conditions. In good ponds and with systempatic breeding and feeding it becomes marketable already at two years of age. Schaeperclaus (1949).

In ponds where the three-year-old weights on the average 180 gr., the four-year-old weights only 250 gr. This is due to the fact that tench in its first years grows faster in ponds than in lakes, but as it grows older its growth slows down rapidly and it falls behind the lake tench. Therefore, Schaeperclaus does not recommend culture of older fish in ponds.

Is fed in ponds with potato, barley, rye, corn, maize, wheat, soybeans and other feeds, but Lupine is apparently the best food.

Hos (1951) wrote that in the Netherlands indigenous Dutch tench is hardly ever used for pond culture. The massuric tench introduced from Poland proved to be a good pond fish and stocking with the two- or three-year-old specimens of this variety results in better catches, both quantitatively and qualitatively.

Tench culture has been done in the U.S.S.R. in the Leningrad province, South Ukrainia and other regions. In the Lower Dnieper region about 30 million larvae have been produced. Berg, Bogdonov, Koshchin and Rass (1949).

In Czechoslovakia during 1934-36, 60 to 90 m.t. were produced from ponds. Berg, Bogdonov, Koshchin and Rass (1949).

(For Transplanting, see 2.1 Delimitation of the total area of distribution and ecological characterization of this area).

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Fig. 1

DISTRIBUTION AND TRANSPLANTING AREAS OF TENCH

Mortimer, C.H. and C.F. Hickling, Fertilizers in Fishponds. A Review and

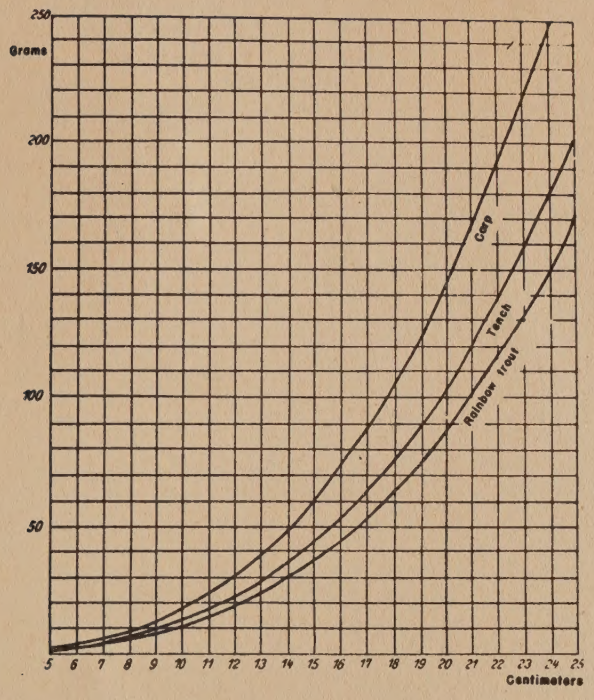

Fig. 2 - Graphic chart of weight of Galician carp, Tench and Rainbow-trout of lengths of from 5 to 25 centimenters, by normal nutrition. (Schaeperclaus, 1933)

Mortimer, C.H. and C.F. Hickling, Fertilizers in Fishponds. A Review and